Innovative 3D Visualization of Electro-optic Data for MCM

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LONG TERM GOALS

Develop innovative methods for transforming data taken by electro-optic and acoustic MCM sensors into graphical representations better suited to human interpretation, specifically to aid mine classification.

OBJECTIVES

The objective of this work is to develop innovative methods to present visualizations of electro-optic sensor data to mine-countermeasure crews. The results of the research would help define a 3D graphical environment to facilitate mine classification by the STIL operator.

APPROACH

Our approach was to develop methods to transform data such that the human could identify objects embedded in complex backgrounds, or scenes. We filtered and otherwise transformed into intuitive graphical representations objects detected with the electro-optic sensors such that the considerable processing power of the human brain could be brought to bear on the mine classification problem.

WORK COMPLETED

During the 2000-2001, ONR 321 funded APL-UW to conduct research on visualization of STIL electro-optic data for MCM classification. The work was divided into the following four subtasks.

1) STIL sensor and data set familiarization and access: We worked closely with representatives from Coastal Systems Center (CSS) and Arete Inc. to understand the nature of the STIL sensor, and we developed data access software.
2) STIL sensor data conditioning: We developed signal and image processing methods to improve the interpretability of STIL sensor data prior to the visualization step. Some of the techniques explored included color mappings, edge detection algorithms, gradient mappings, and morphological

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processing. For example, through contour thresholding, we compared the contrast portion with the range portion of the STIL sensor data, emphasizing object boundaries. We applied morphological processing in order to select certain "mine-like" objects for further investigation.

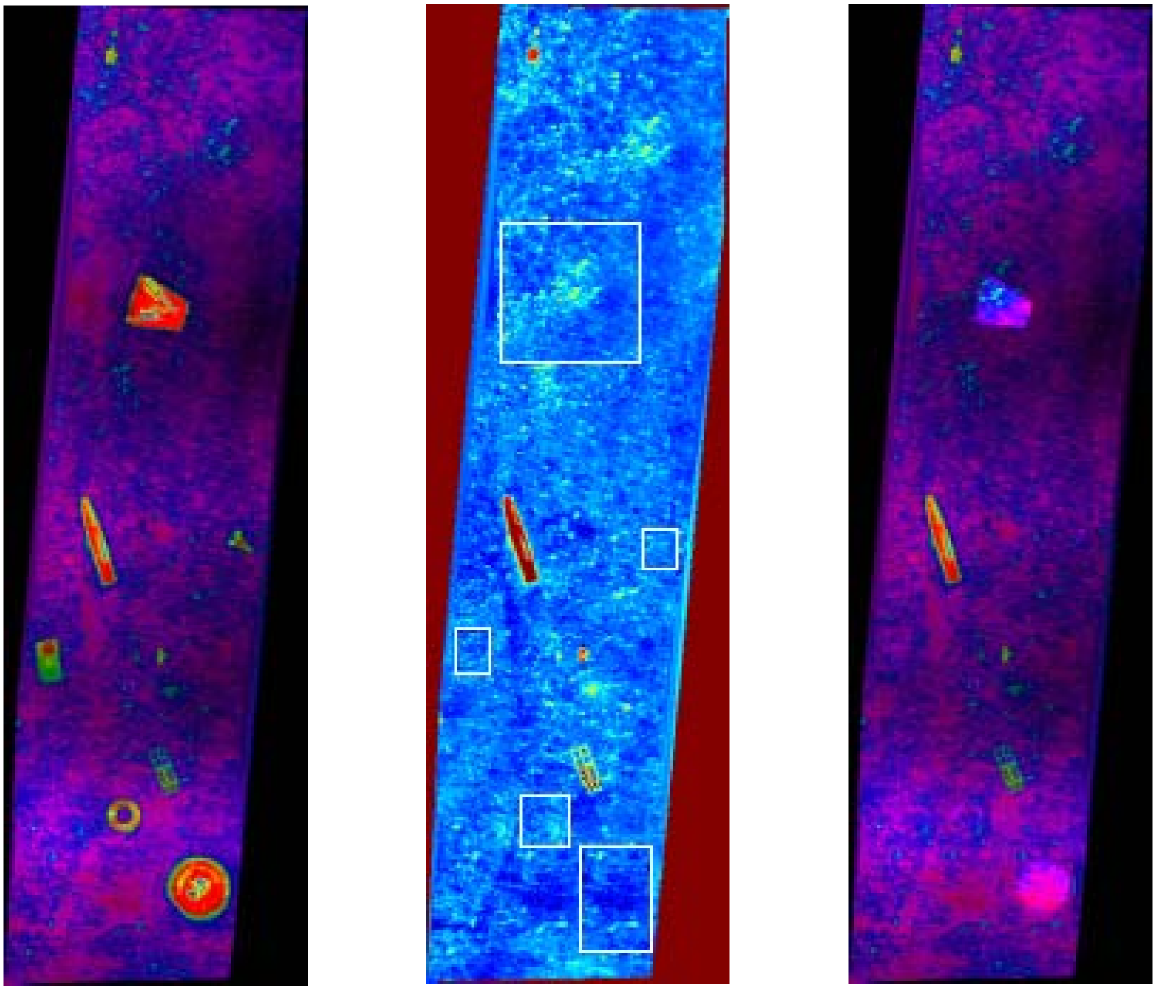

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Figure 1. (A) A specialized color mapping applied to the range and contrast data highlights objects on the sea floor. (B) The white rectangles indicate areas where the contrast portion of the data has been replaced with images of the bottom. The range data is unmodified, thus simulating objects covered with a light layer of sand. (C) Using the same color map as in image A, the simulated sand-covered objects are still visible for the objects that have resolvable depth (e.g., the flat contrast board is not visible, while the two mines are).

3) Development of STIL sensor visualizations to aid target classification: We used commercial-off-the-shelf (COTS) visualization packages to determine optimal ways to present complex STIL imagery to a human (Figure 2). Both 2D and 3D visualizations were explored. We began to create a mine template library (Figure 3). This library allows the operator to compare an object to known mines.

Figure 2. A screen-shot of the user interface prototype. This prototype was developed to investigate user interface issues related to presenting sensor data to an operator. It demonstrates how the data could be displayed using both 2D and 3D visualizations.

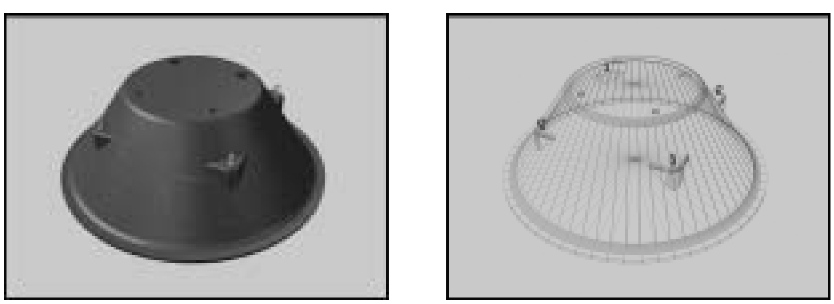

Figure 3. Shaded and wire-frame views of mine models present in the mine template library. This library aids in classification by allowing the operator to compare an object to known mines.

4) Development of a software evaluation testbed: For this task we took the most promising techniques from the previous subtasks and incorporated them into a visualization testbed. This testbed was developed using the Java programming language, which has extensive libraries for image processing and data visualization, and can be easily run on various hardware and operating systems. The testbed was developed on general purpose Unix/Linux workstations and provides 2D and 3D images with associated image tuning parameter controls and 3D rotation/translation controls. (Figure 4)

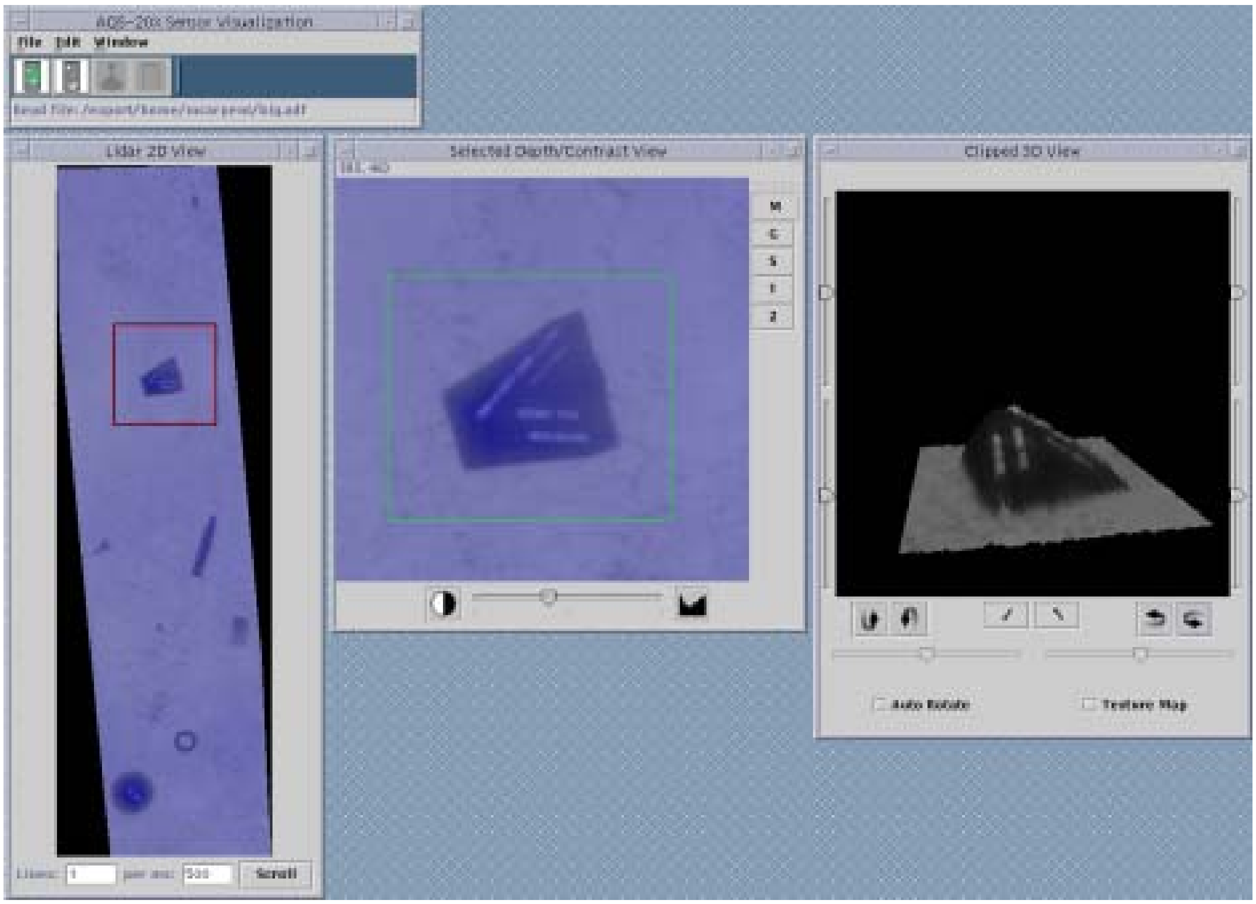

Figure 4. A screen shot of the Java-based visualization testbed. The testbed is a working application built upon the ideas developed in the user interface prototype, and incorporates promising signal and image processing techniques as they are developed. The upper left window, the main control panel, controls which of the application windows are displayed. The lower left window contains a scrolling 2D image of the STIL sensor data. In the middle window is a magnified version of the data in the red rectangle. A 3D view of the data in the green rectangle occupies the right window. This 3D view can be rotated to view the object from various angles.

RESULTS

Our results can best be described in the figures and their captions.

IMPACT/APPLICATIONS

These methods can be applied to data from other sensors, such as acoustic sensors.

TRANSITIONS

Transitions at this time are premature; we anticipate these will be identified under future funding.

RELATED PROJECTS

We understand that ONR has not funded other visualization projects within the optics program.